Integrating Risk in Cost Estimates and Earned Value Management

A Management Issue!

Business Managers Conference
May 04

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Outline

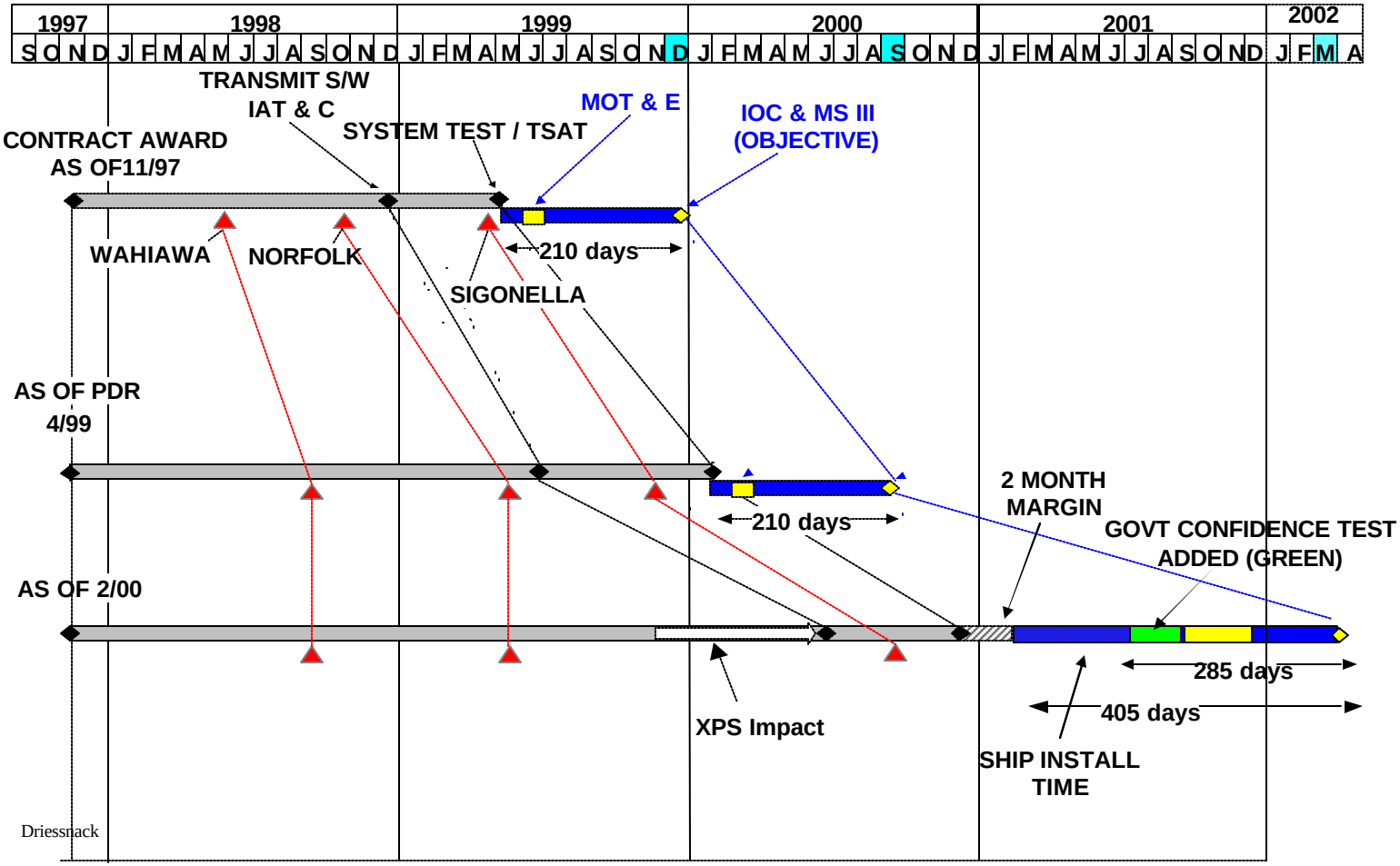
- The Problem … risk and uncertainty in the program
  - Old 5000 & PPBE wanted point solutions
  - New DoD 5000 wants realism…
  - Management Team needs to join forces

- A Management issue … not a technical issue
  - Many ways to incorporate risk into cost estimates
  - Risk CoP briefs … desire to quantify risks

- Earned Value/Contracts incorporate realism
  - NDIA RISK/EV working group … survey
  - Proposed approach … evolving concept

- Discussion … managers require integration!

Schedule History
(as briefed on 3 May to DAE)



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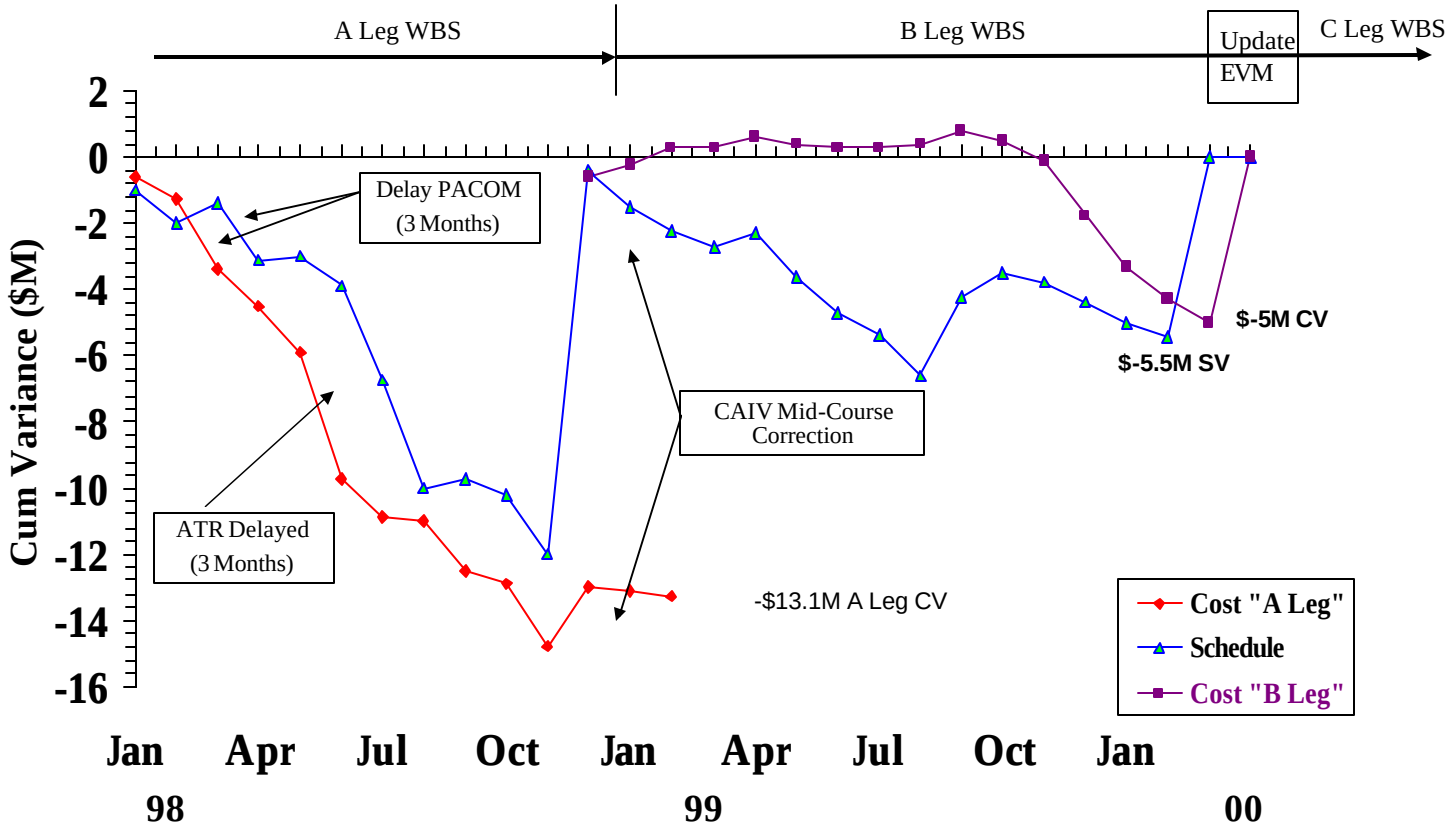
GBS EVMS Evolution

Cumulative Dollar Variance



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As of Jun 00
Rebaseline

DoD "old" Policy
Selected References to RISK

- **DoDD 5000.1, The Defense Acquisition System**
  - **4.5. Effective Management….tailor considering risk**
- **DoD 5000.2-R, Mandatory Procedures for MDAPs/MAIS**
  - **Numerous references to RISK....management and mitigation**
  - **1.2.4.2 Risk reduction in source selection criteria**
  - **1.4.3.3.2 Cost Estimates include assessment of RISK**
  - **2.3, 2.5, 2.9 Acquisition Strategy …reduce System-Level risk to acceptable levels…industry bear risks**
  - **5.2.3.4.3…establish a risk management process**
  - **7.4 Exit Criteria**
- **DoDD 5000.4, OSD CAIG**
  - **The CAIG Chair report … include quantitative assessments of risk…**
- **DoD 5000.4-M, Cost Analysis Guidance and Procedures**
  - **Para 1.E.1.2, … Subsystem Description address risk issues**
  - **Para 1.E.2.0, Risk..PM assess & plan to address/reduce**

Program Baselines

	Threshold	Objective
Performance	Minimum acceptable level which will meet user need	Cost effective increment in operational capability above threshold
Cost	RDT&E, MilCon, Proc & AUPC, PAUC Objective + 10%	Planned cost to meet program objectives
Schedule	6 Months beyond objective date (3 months for ACAT IA)	Planned event dates to meet program objectives

Does not represent the RISK on a Program
No baseline for, or tracking of Risk

New 5000.2 – no suggested 10% or 6 months

DoD "new" Policy

References to RISK – 22 to 22!

- **5000.1**
  - **4.3.1 Flexibility …no one best way**
  - **4.3.2 Responsiveness …time phased capability**
  - **4.3.4 Discipline …program goals for minimum number…**
  - **4.5 Streamlined and Effective Management …decentralize to maximum extent practicable**
  - **E1.5 Cost Realism…proposal that are realistic**
  - **E1.6 Cost Sharing…undue risk is not imposed (contractor)**
  - **E1.14 Knowledge-Based Acquisition…**
    - **Tech, Integration, and manufacturing risk reduced**
  - **E1.21 Program Stability …realistic program schedules.**
  - **E1.27 Systems Engineering approach**
- **5000.2**
  - **19 references to Risk**

Risk and Realistic in enough paragraphs?

Delusions of Success

How Optimism Undermines Executive's Decisions

By Lovallo and Kahneman; HBR July 03

- Lists numerous examples of failures in Industry
- Reject "rational risks in uncertain situations"
- Propose over optimism from cognitive biases
  - errors in way mind processes information
  - organizational pressures
- Problems
  - Anchoring – initial plan accentuate the positive
  - Competitor Neglect – underestimation of negative events
  - Organizational Pressure – internal competition big incentive to accentuate positives in forecasts
- Optimism in Its Place – a distinction between
  - functions and positions that
    - involve decision making
    - that promote or guide action

Why Good Projects Fail Anyway

By Matta and Ashkenas; HBR Sept 03

- **Focus on "execution risks" and neglect;**
  - **"white space risk" – unknowns**
  - **"integration risk" – disparate activities won't come together**

- **Suggest a "rapid-results initiative"…spirals!!**

- **Closing paragraph: "Attempting to achieve complex goals in fast-moving and unpredictable environments is humbling. Few leaders and few organizations have figured out how to do it consistently. … Managers expect they will be able to identify, plan for, and influence all the variables and players in advance, but they can't. Nobody is that smart or has that clear a crystal ball. They can, however, create an ongoing process of learning and discovery, challenging the people close to the action to produce results – and unleashing the organization's collective knowledge an creativity in pursuit of discovery and achievement."**

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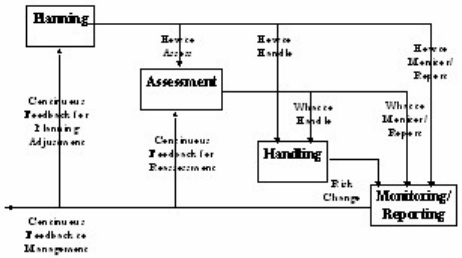
All Risk Management Processes Are Basically the Same

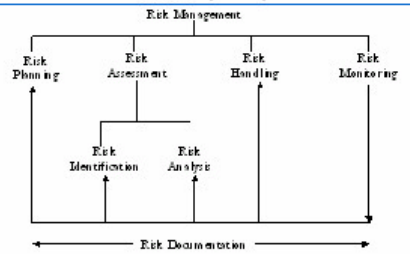
SE Fundamentals Risk Process (DAU)



Risk Management Process

Presented at ASN Seminar May 2002

DoD Risk Management Guide (DAU)



NAVAIR

The NASA Risk Management Process

USAF Risk Management Structure

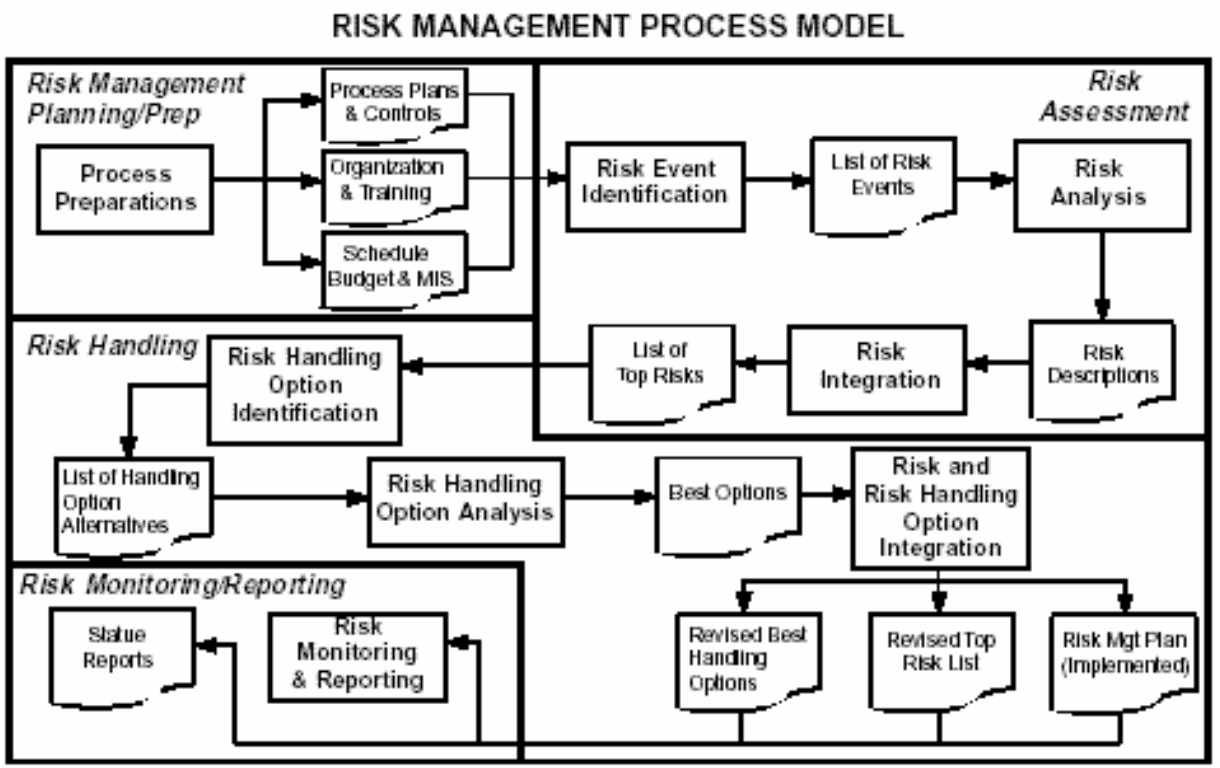
Based on DoD Risk Management Study

NAVAIR

F/A-18 Risk Management Process

Plan/Define – Assess (Identify + Analyze) – Handle – Communicate/Track/Monitor/Control – Evaluate

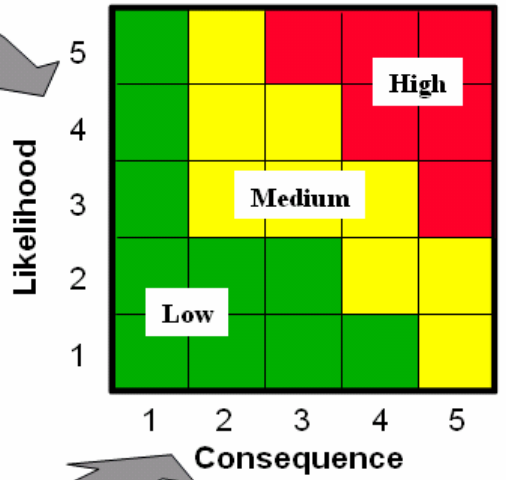
DAU PM Tool Kit Feb 2002



F/A-18 Program Risk Analysis

Likelihood

What is the likelihood the risk will happen?		
Level		Planned Approach and Processes…
1	Not Likely:	…Will effectively avoid or mitigate this risk based on standard practices
2	Low Likelihood:	…Have usually mitigated this type of risk with minimal oversight in similar cases
3	Likely:	…May mitigate this risk, but workarounds will be required
4	Highly Likely:	…Cannot mitigate this risk, but a different approach might
5	Near Certainty:	…Cannot mitigate this type of risk; no known processes or workarounds are available



Consequence

Given the risk is realized, what would be the magnitude of the impact?			
Level	Technical	Schedule	Cost
1	Minimal or no impact	Minimal or no impact	Minimal or no impact
2	Minor perf shortfall, same approach retained	Additional activities required; able to meet key dates	Budget increase or unit production cost increase <1%
3	Mod perf shortfall, but workarounds available	Minor schedule slip; will miss need date	Budget increase or unit production cost increase <5%
4	Unacceptable, but workarounds available	Program critical path affected	Budget increase or unit production cost increase <10%
5	Unacceptable; no alternatives exist	Cannot achieve key program milestone	Budget increase or production cost increase >10%

Questions about Risk Management?
Call a member of the Risk Mgmt Team

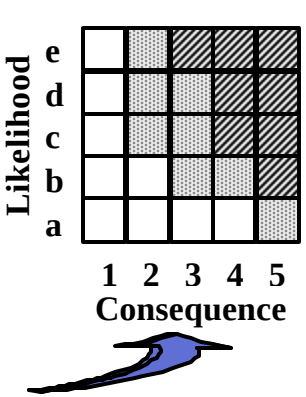
Rich Gilpin	NAVAIR	301-757-7621
Mike Danko	Veridian	301-866-5680
Jim Warren	Boeing	314-234-8754
Jo Anne Wood	NGC	310-332-9331
Jim Huffman	GE	781-594-5724

NSSN Risk Assessment Process

Questions about Risk Management?

Call a Member of the Process Integration Team for Risk.

ASSESSMENT GUIDE



***LIKELIHOOD*:**

Level	What Is The Likelihood The Risk Will Happen?
a	Remote
b	Unlikely
c	Likely
d	Highly Likely
e	Near Certainty

RISK ASSESSMENT

HIGH - Unacceptable. Major disruption likely. Different approach required. Priority management attention required.

MODERATE - Some disruption. Different approach may be required. Additional management attention may be needed.

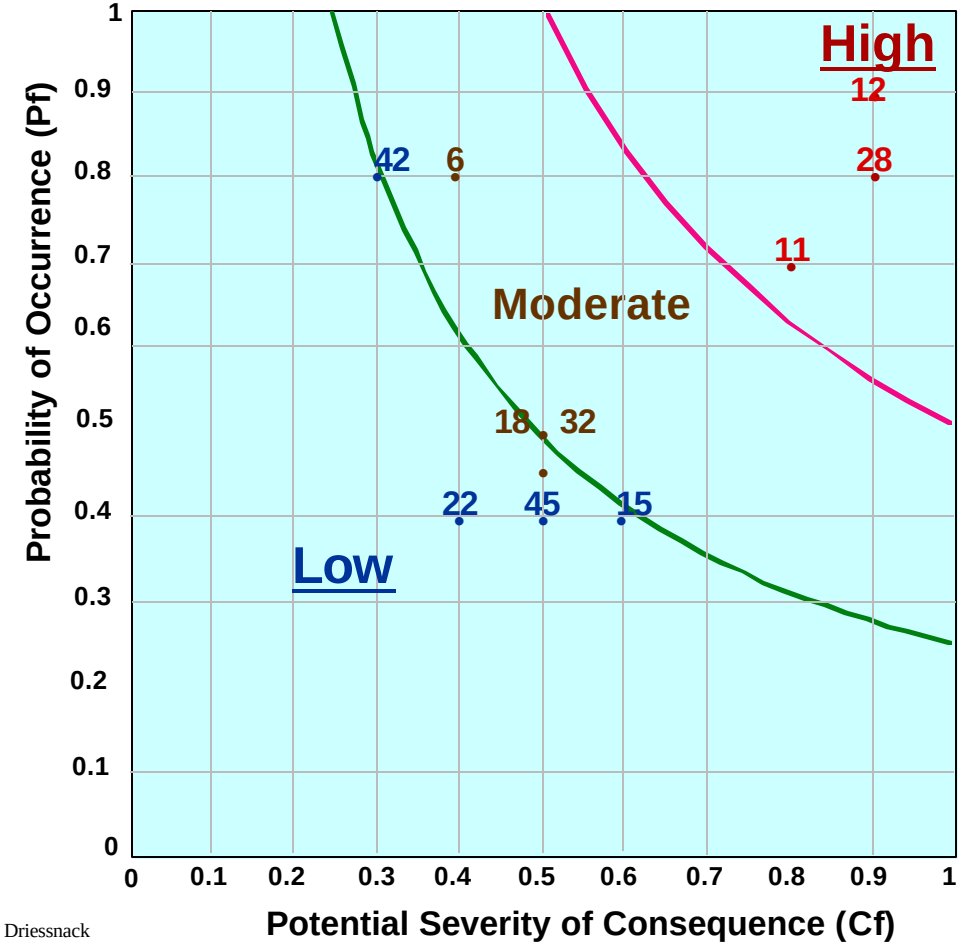
LOW - Minimum impact. Minimum oversight needed to ensure risk remains low.

***CONSEQUENCE*:**

Given The Risk is Realized, What is the Magnitude of the Impact?

Level	Technical Performance	and/or	Schedule	and/or	Cost	and/or	Impact on Other Teams
1	Minimal or No Impact		Minimal or No Impact		Minimal or No Impact		None
2	Acceptable with Some Reduction in Margin		Additional Resources Required; Able to Meet Need Dates		< 5%		Some Impact
3	Acceptable with Significant Reduction in Margin		Minor Slip in Key Milestone; Not Able to Meet Need Dates		5 - 7%		Moderate Impact
4	Acceptable, No Remaining Margin		Major Slip in Key Milestone or Critical Path Impacted		> 7 - 10%		Major Impact
5	Unacceptable		Can't Achieve Key Team or Major Program Milestone		> 10%		Unacceptable

Top Risks



12 Safety Reqt's Exceeds Spec

28 Family of Systems

11 Safety of Crew in Cab

6 PRS #2 Availability

18 Reloader Redesign

32 Safety impacts Design

15 High Failure Rates

42 DT Duration too short

45 Turret Servo Maturity

22 Insufficient Spares

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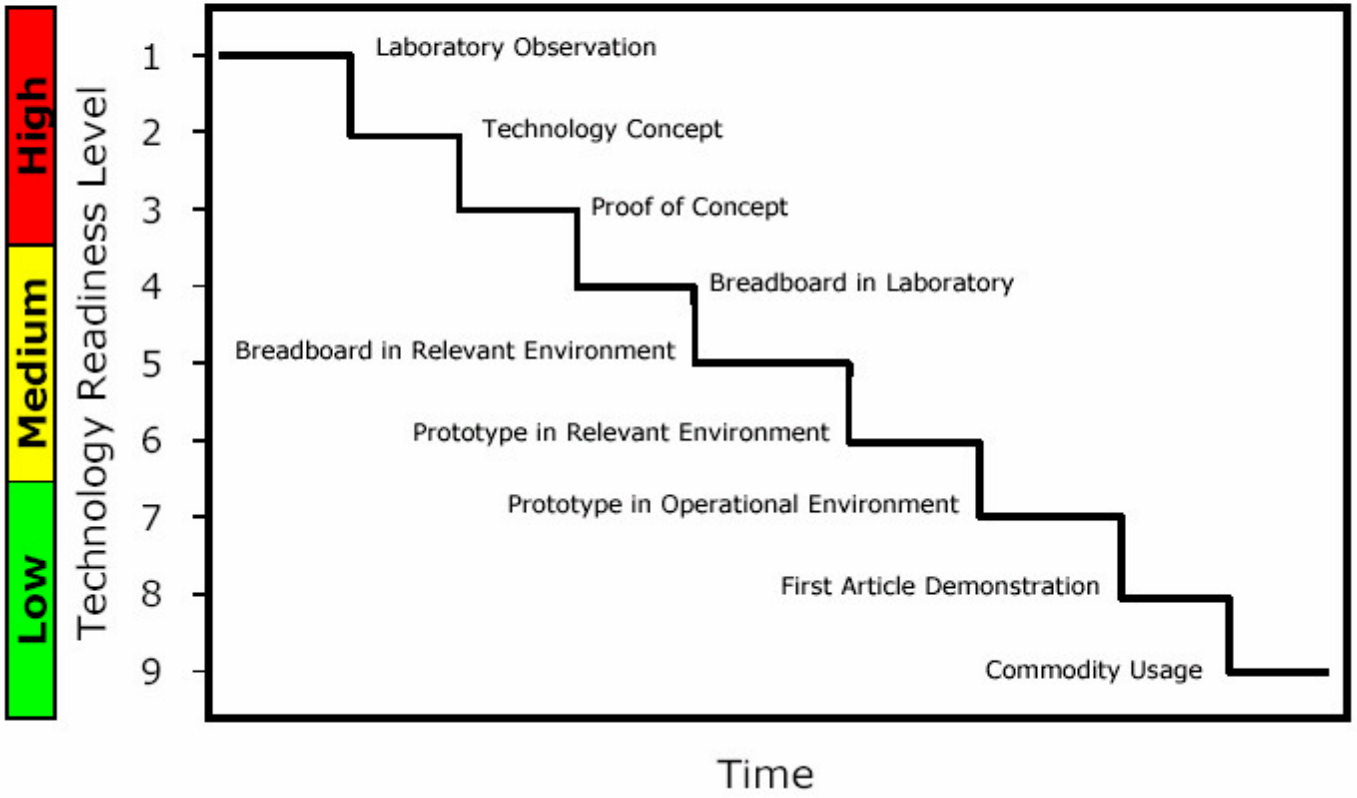
Risk Waterfall



Dri

Risk In Cost Estimating

General Introduction

&

The BMDO Approach

33rd ADoDCAS
2-4 February 2000

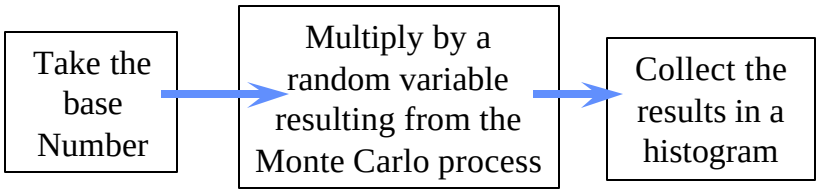
R. L. Coleman, J. R. Summerville, M. DuBois, B. Myers

rcoleman@tasc.com, (703) 631-2000 x2181

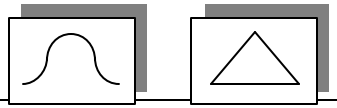
Litton TASC

BMDO Cost Risk Model

Steps:



Example (one iteration):



WBS	Initial Point Estimate	CE draw	S/T draw	Estimate with Risk
1.0 Hardware	100M			127M
1.1 Item 1	80M	1.1	1.15	100M
1.2 Item 2	20M	1.15	1.2	27M
2.0 SW	10M	1.03	1.3	13M
3.0 SE/PM	11M			14M
Total	121M			168M

Some elements are roll-ups

Some elements are factors off of others

The result is an estimate with risk

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Litton TASC

Five Steps for Using Risk+

I. Plan your project

In order to use Risk+ you must have a project plan prepared in MS Project '98. The plan should have a complete critical path network in to achieve meaningful risk analysis results.

II. Select tasks for detailed analysis

Risk+ will collect and generate detailed statistical information for tasks you identify in this step. Typically, only the key or high risk tasks are analyzed, rather than analyzing all the tasks in the project plan.

III. Enter risk parameters

You must enter minimum, most likely, and maximum duration and cost information for each program activity (low level task). Additionally, you must specify the relative likelihood of outcomes within each range.

IV. Run the risk analysis program

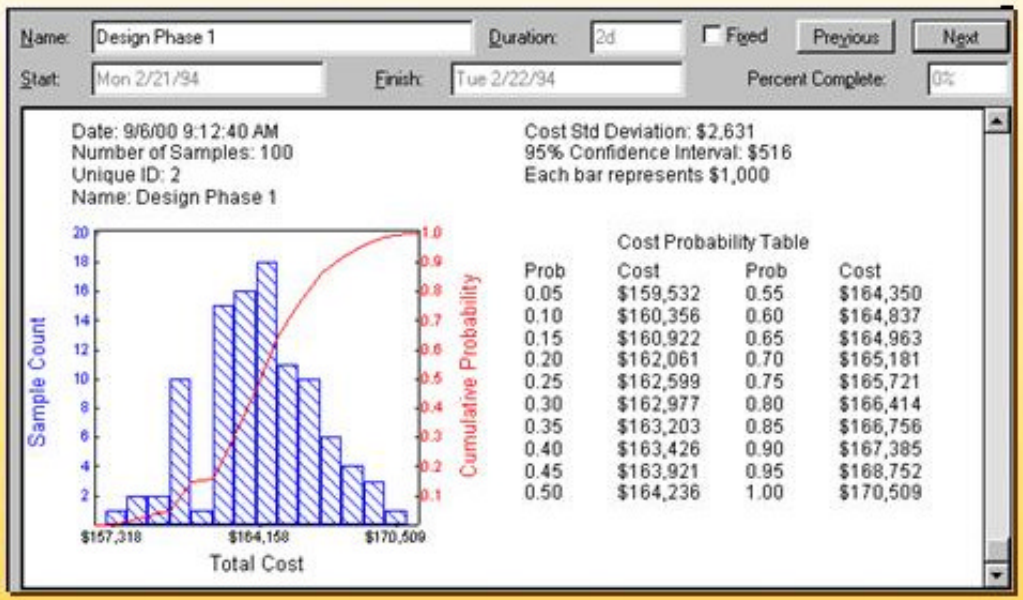
In this step, you tell Risk+ what analyses to perform, and how many possible outcomes to examine before generating its results.

V. Review risk analysis results

Risk+ generates a variety of graphical reports (histograms) which you can use to evaluate the effects of risk on your project.

"CLICK" TO CONTINUE...

Cost Histogram



The **Cost Probability Table** shows the probability that the task will be completed for a certain cost.

"CLICK" TO CONTINUE...

Advanced Project Schedule Risk Analysis

Presented by

David T. Hulett, Ph.D.

Hulett & Associates, LLC
Project Management Consultants

Los Angeles, CA USA
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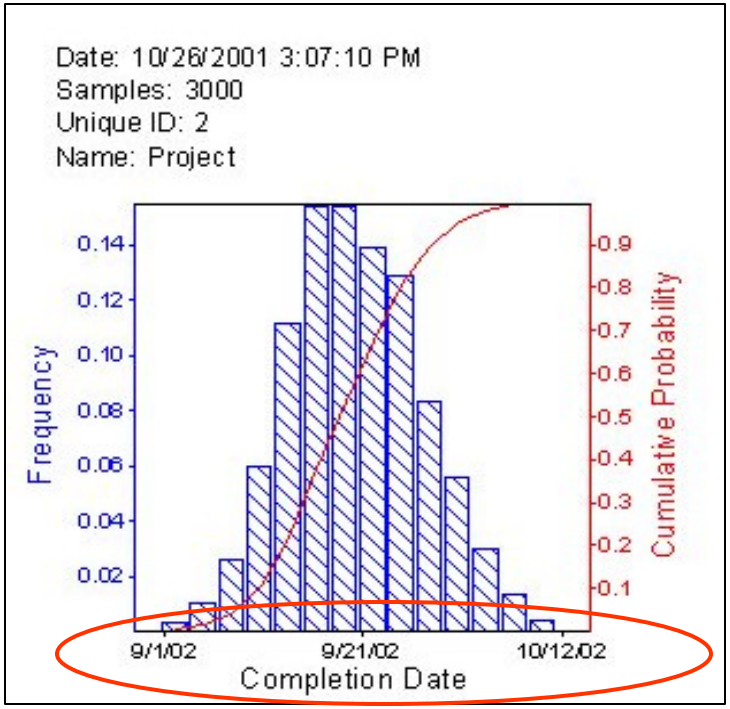
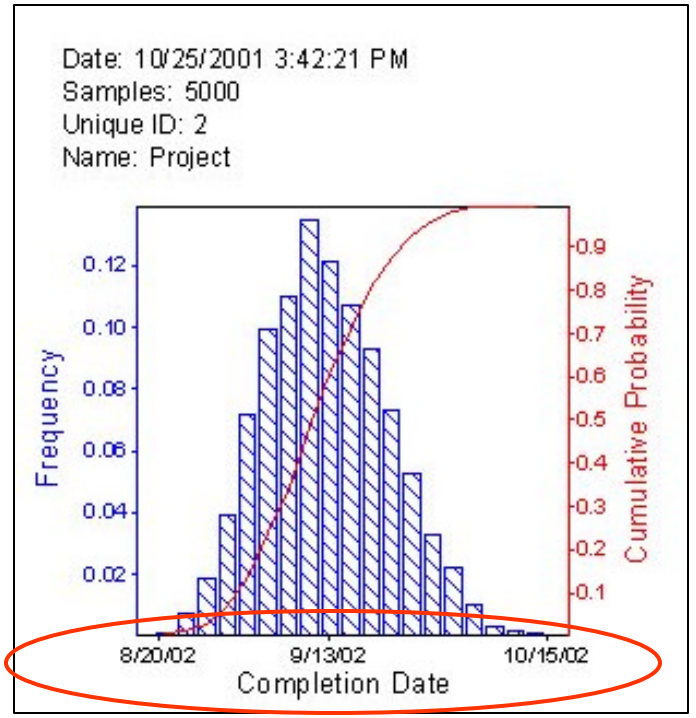
Evidence of the Merge Bias

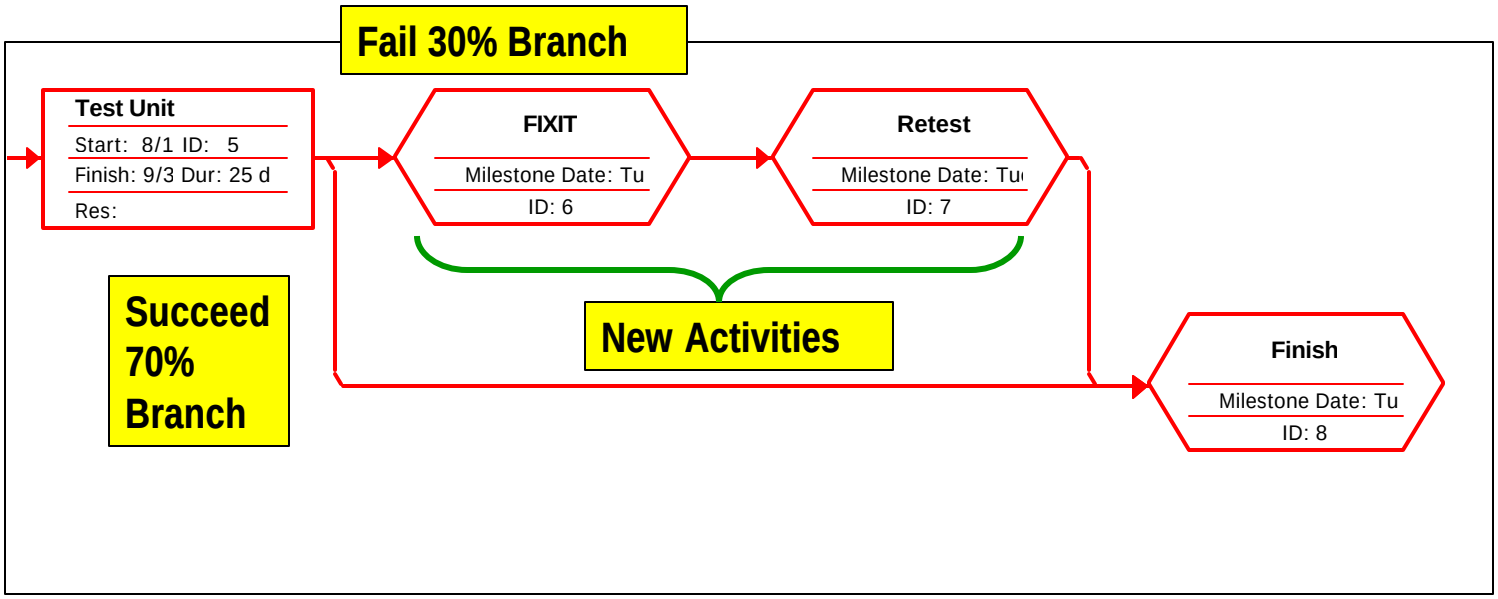


Three Path Schedule

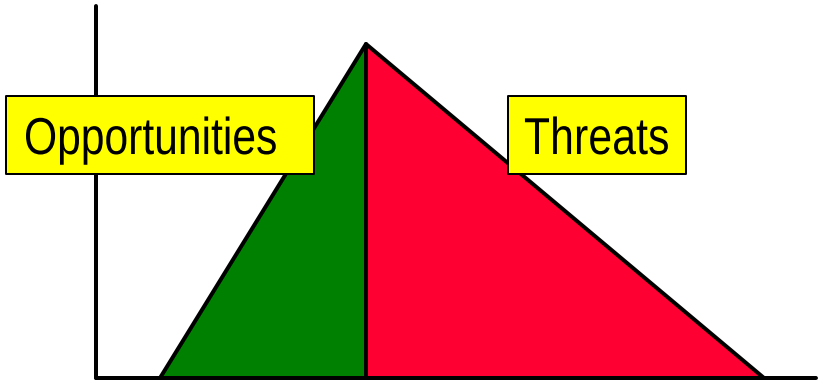


One Path Schedule

Logic of Probabilistic Branch

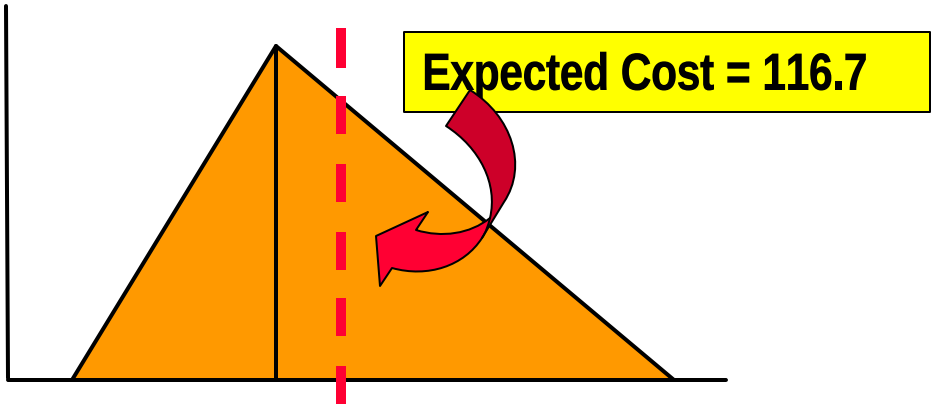


Triangular Probability Distribution



- Relative likelihood determined by the height of the triangle
- Impact determined by X-Axis
- Easy to use, commonly used

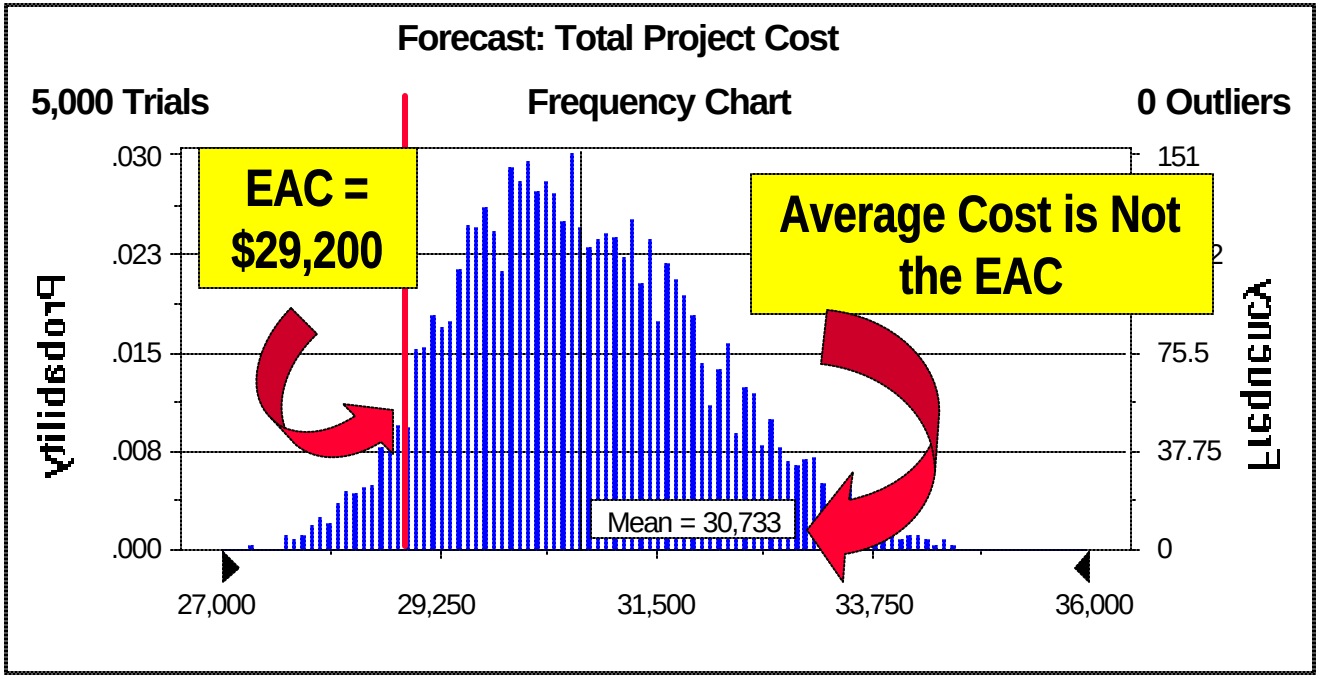
Some Analysis Using the Triangular Distribution



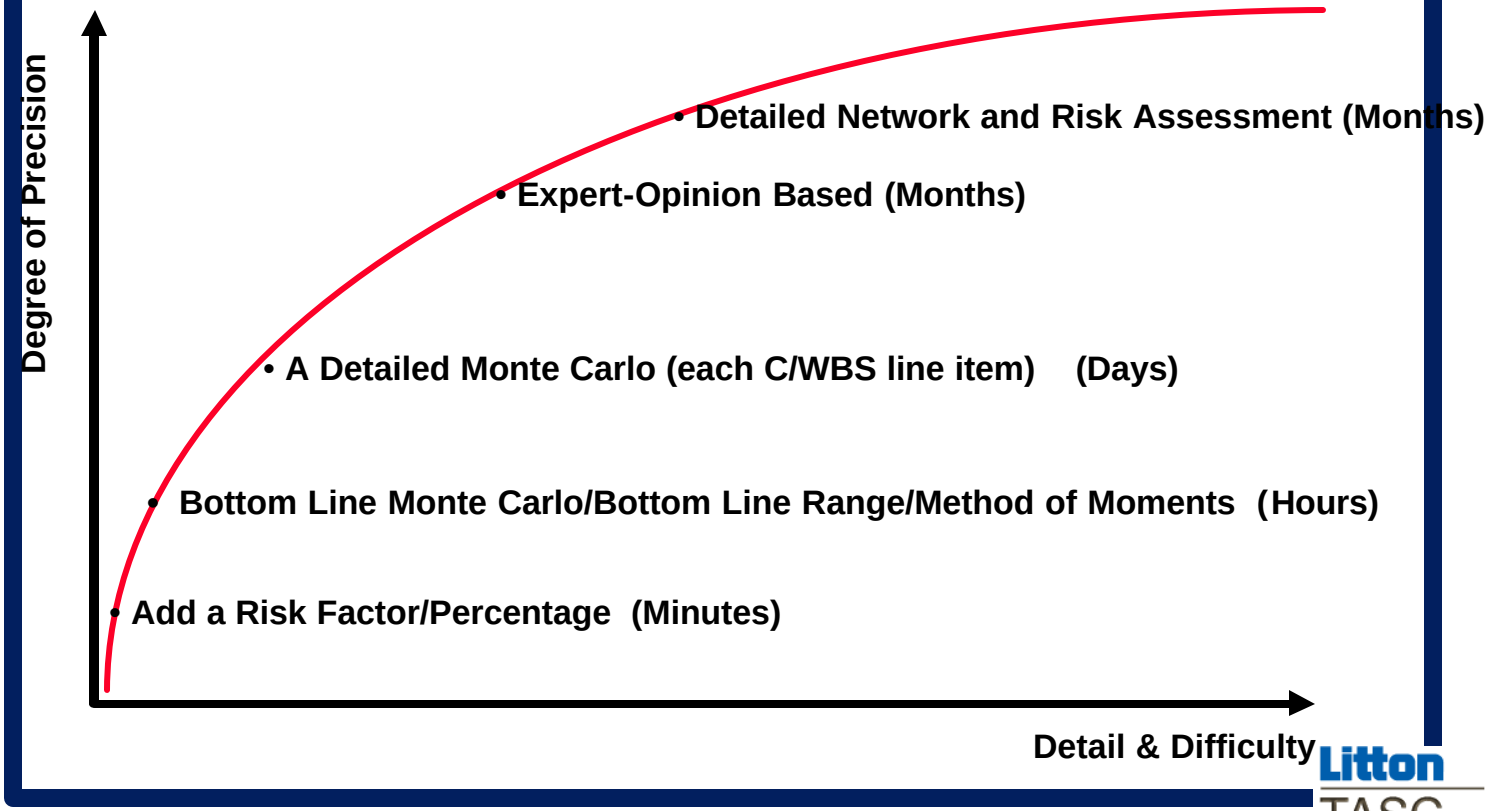
Average (expected) cost = (low + most likely + high) / 3

(70 + 100 + 180) / 3 = 350 / 3 = 116.7

The EAC is Not the Average Cost. It is Not Even the Most Likely Cost!

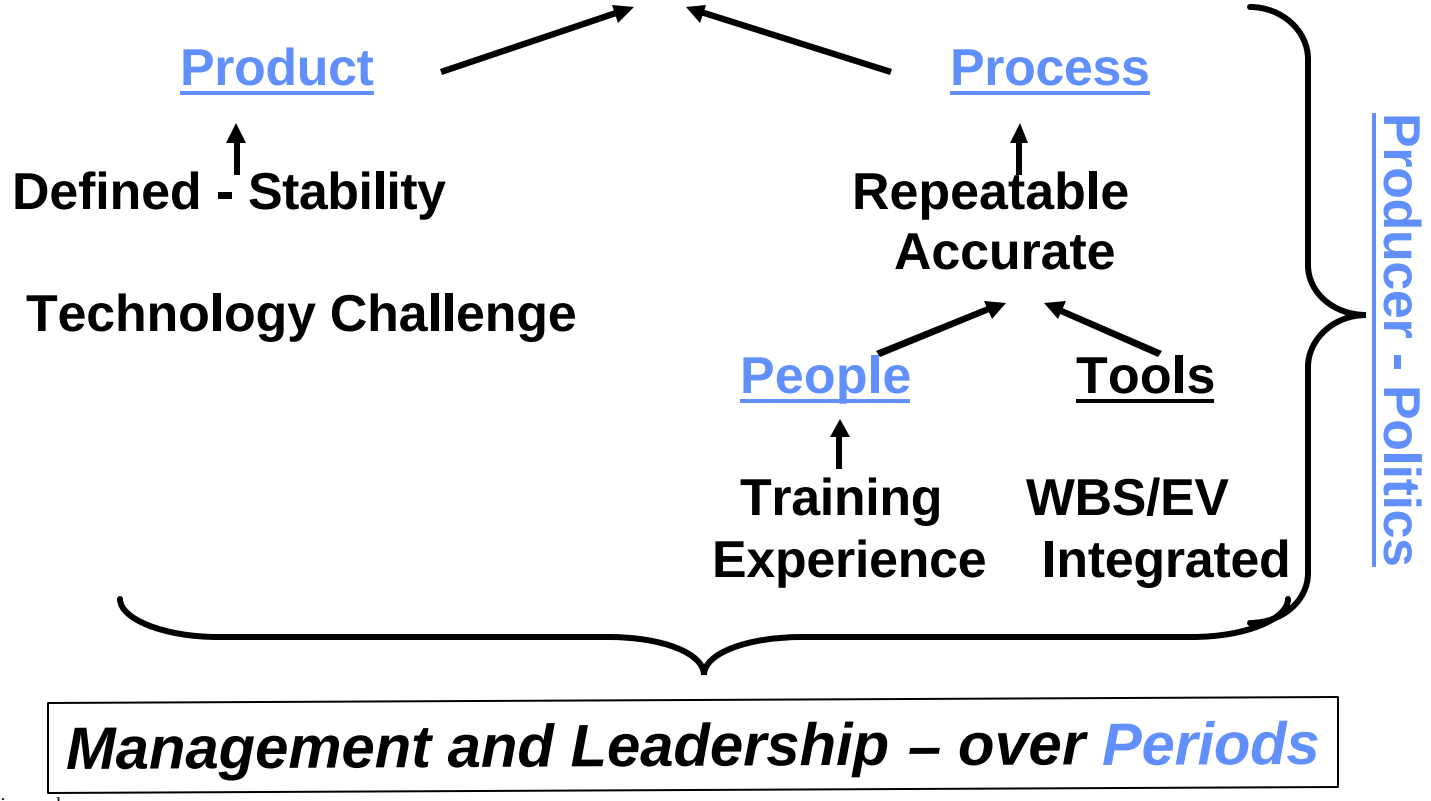


Risk Assessment Techniques

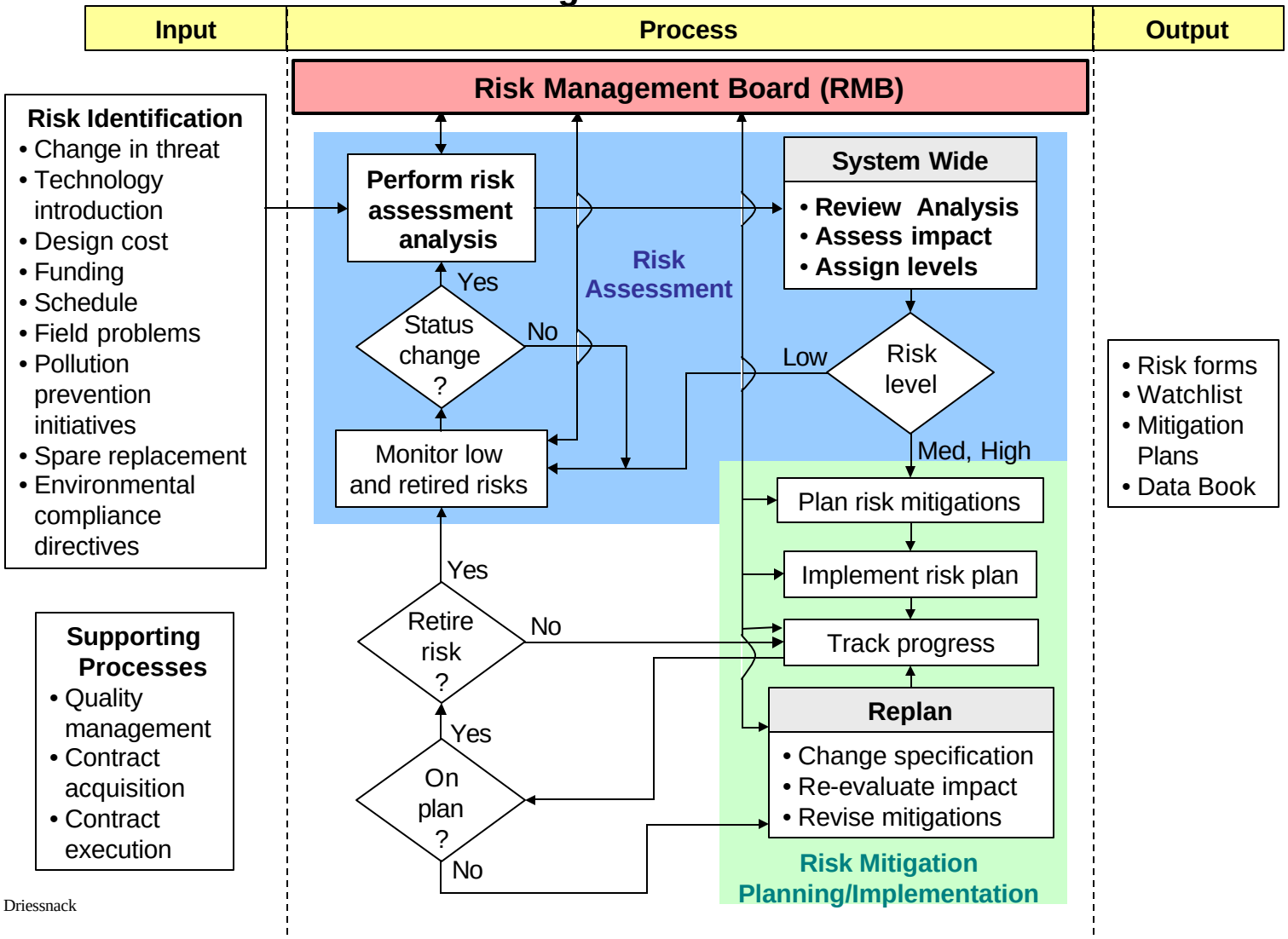


DoD Weapons Acquisition

PM Framework Measures



.... Risk Management Process from ...



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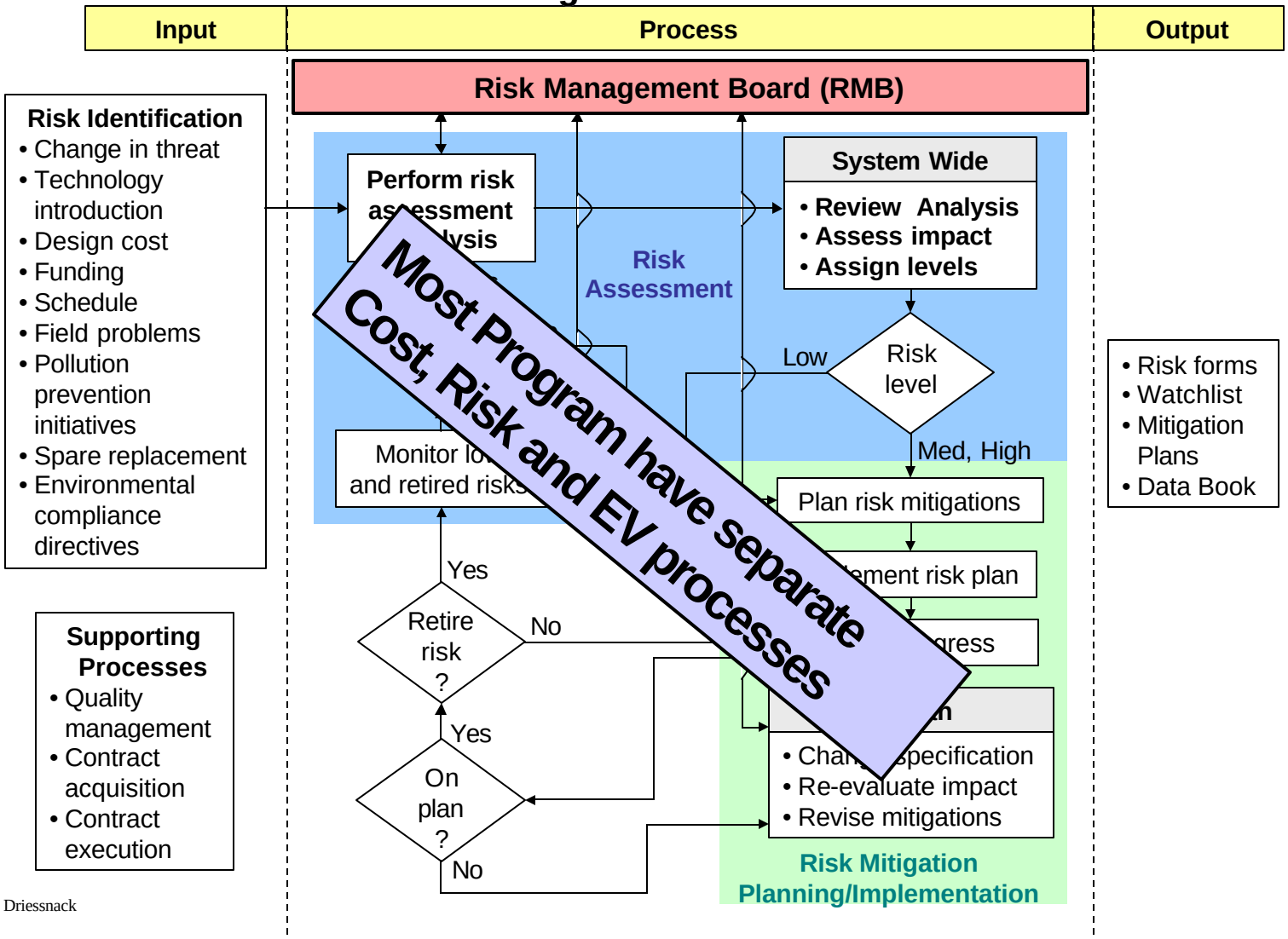
.... Risk Management Process from ...



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Risk Integration

- Technical approaches exist…need to require them
  - Quantify Risks … qualification not as useful
  - Require risk assessments in Cost, Sched, Tech
    - Management needs to decide how far you go!
  - Ask for ranges … require simulations
    - Management decides what point solution to use

- Risk Boards, Cost IPTs, etc … this is a problem
  - Need an Integrated Process Team
    - Work from common Program WBS…
    - Synergies from assessments efforts

- The Integrated Product Teams are responsible
  - You get what you measure…so measure risk
    - Inside the Cost, Sched, Tech products

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Risk Management Survey

- Anonymous survey sponsored by NDIA Program Management Systems Subcommittee (PMSS)
- Survey initially hosted by DAU on 9/8/03
- Survey still available at: http://mdc.dau.mil/mdcsurvey/rm-evm03/rm-evm03.htm
- Follow-up survey announcement sent by NDIA on 30 March 2004
- Officially, Survey will end by June 2004. DAU may continue to use to gather information for its own use

Survey Results: Process Owner vs. Champion

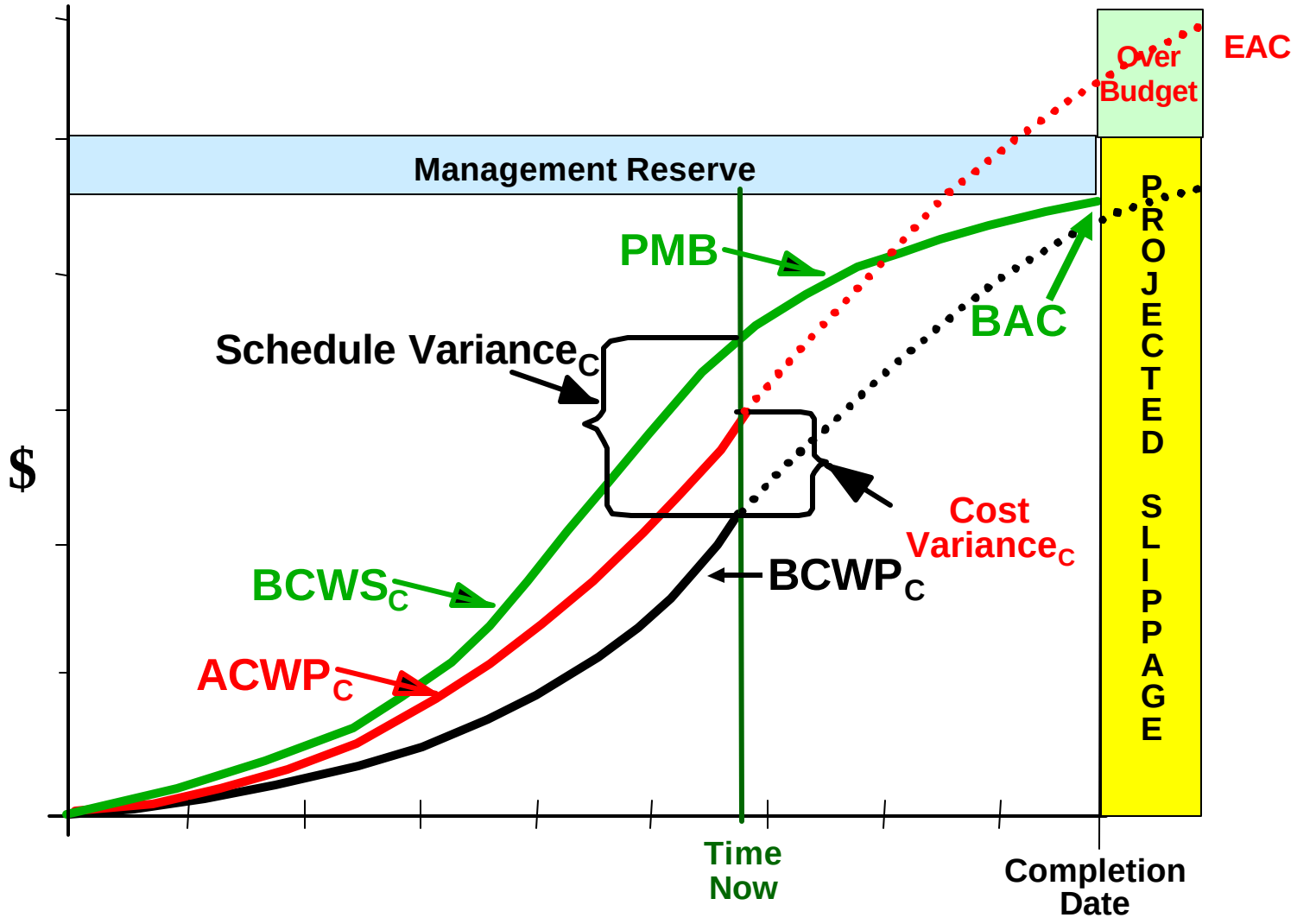
	Risk Management	EV Management
Formal Process Ownership*	PM or Systems Engineering	Business Management/Other
Process Champion/Sponsor*	PM or Systems Engineering	Business Management/Program Controls

*These excerpts contain only the portion of the responses consisting of those most frequently selected by survey respondents

Survey Results: Process Integration

Degree of effectiveness of process integration	**38% – Effectively** **35% - Neutral** **27% - Poorly**
Barriers to integration*	**Contractual incentives/disincentives** **Technology** **RM or EVM process maturity** **Knowledge/training** **Internal/external management cultures** **Organizational** **Baseline instability** **Emotional (e.g., fear of failure)**
There is value integrating these two processes	**71% - Strong** **17% - Moderate** **6% - Lesser**

***These excerpts contain only the portion of the responses consisting of those most frequently selected by survey respondents**


EAC
Over Budget
Management Reserve
PROJECTED SLIPPAGE
PMB
BAC
Schedule Variance$_C$
Cost Variance$_C$
BCWS$_C$
BCWP$_C$
ACWP$_C$
$
Time Now
Completion Date

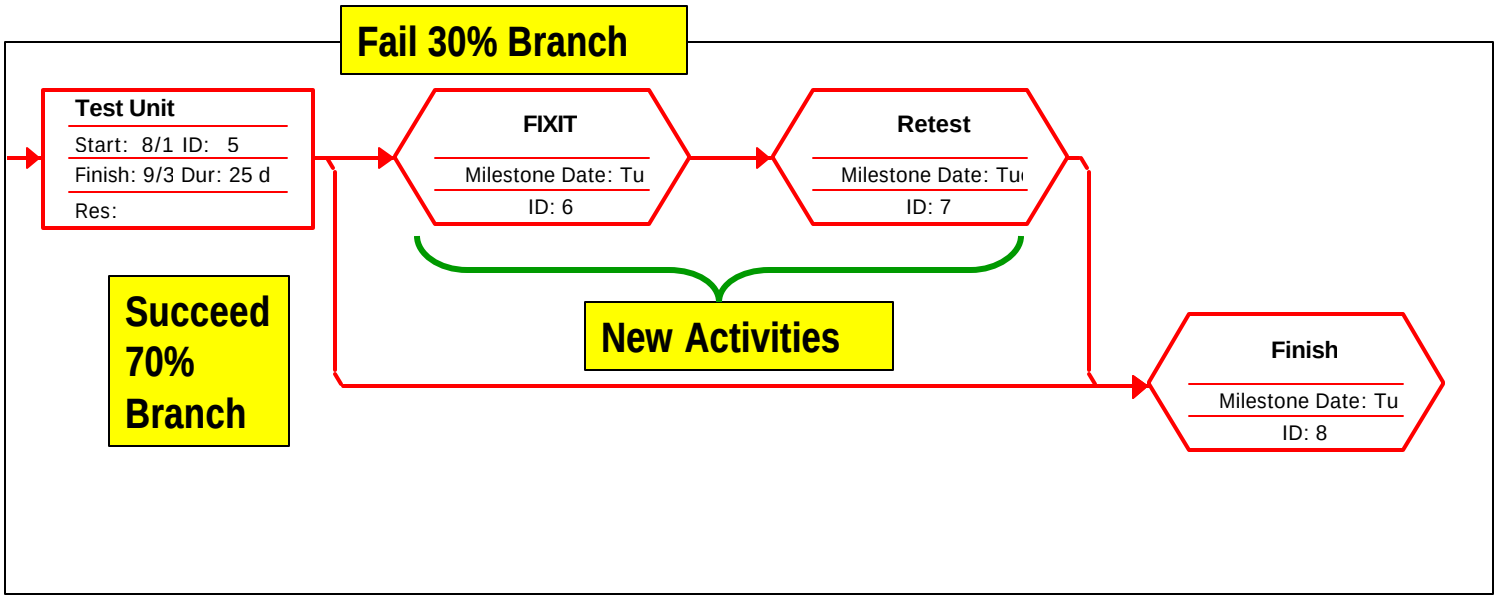
Integrate Risk into EV Baseline

- Need to move beyond Management Reserves
  - … 10-20% stretch goals

- Development of schedules with risks quanitfied:
  - Work Package (events) that have…
    - Alternative paths…with probabilities
    - Characterizing c/s/p beyond points solution
  - Run simulation to obtain range of possibilities

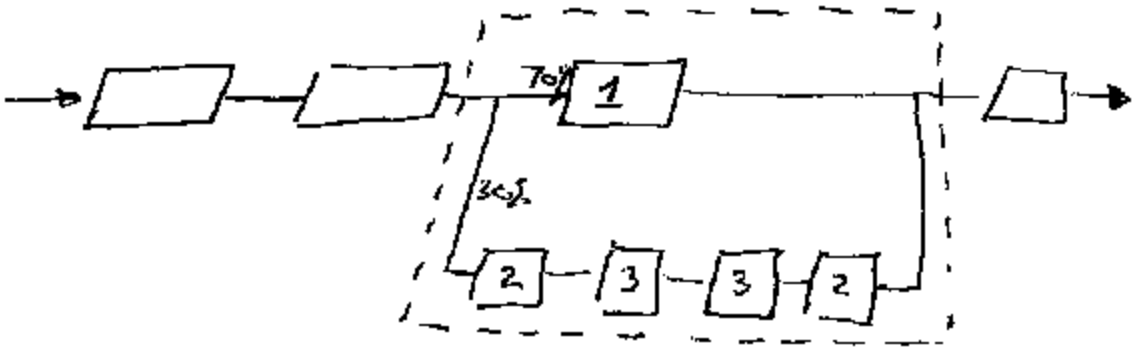
- Incorporate into EV to get EAC "box" of possibilities
  - Develop a Risk Performance Index
    - Track realize or retired risks…
    - Index like SPI…improves at the end
  - Develop Technical Performance Index
    - Track overall performance against baseline

Logic of Probabilistic Branch



Schedule with Probabilistic Branches

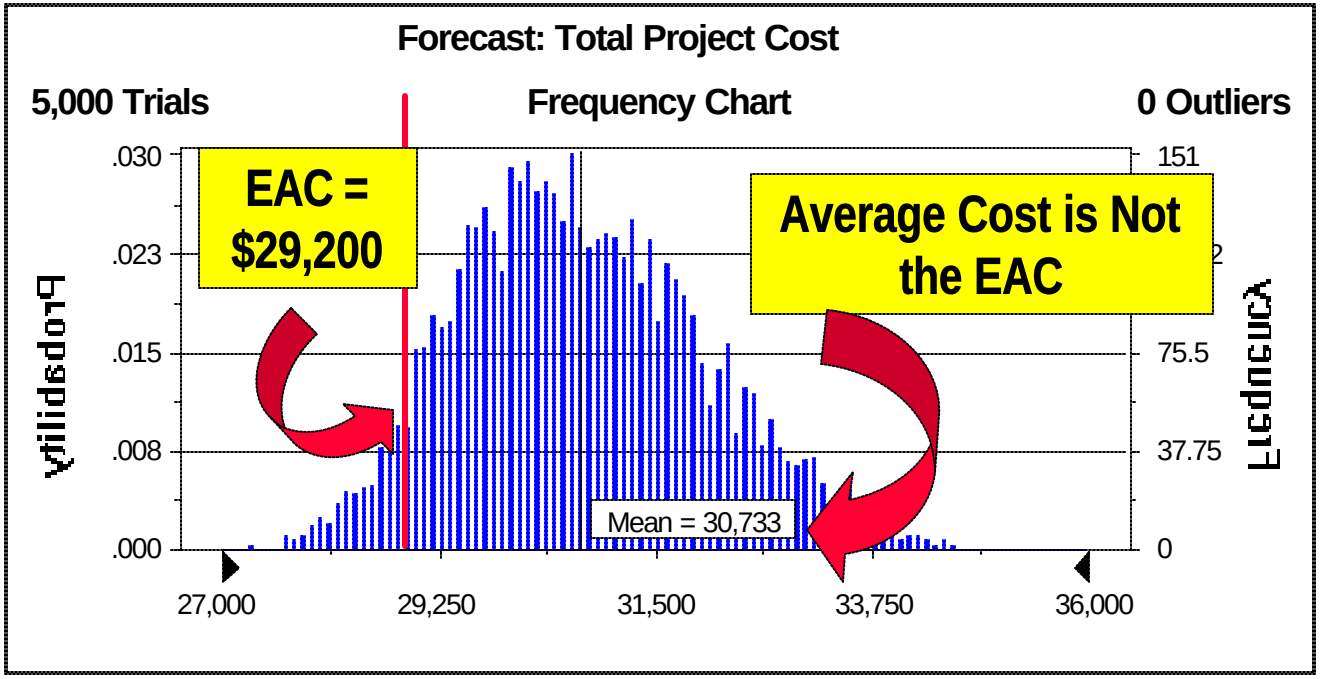
…plan in the alternatives that you might need to take

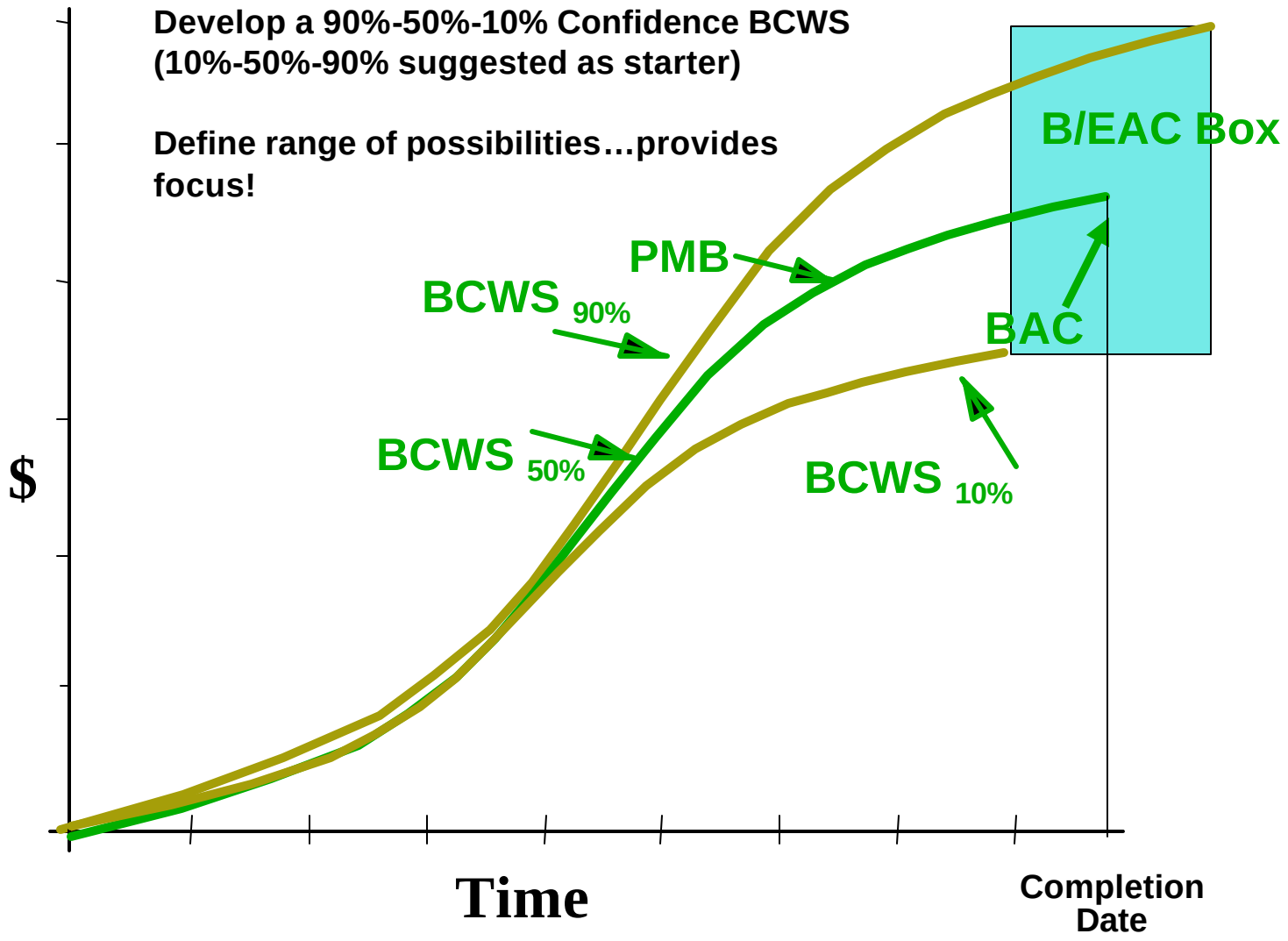


- Package value at: .70 (1) + .30 (10) = 3.7
  - PM distributes 3.7 - .74 = 2.96 (minus 20% reserve)
  - Account owner hopes to get lucky!
- Alternative is distribute 1.0
  - Track if “event” draws more allocation
  - “event” driven increase would show up in Risk PI

- What risks are variance…need focus in Work Package

The EAC is Not the Average Cost. It is Not Even the Most Likely Cost!




Develop a 90%-50%-10% Confidence BCWS
(10%-50%-90% suggested as starter)
Define range of possibilities…provides focus!
B/EAC Box
PMB
BCWS 90%
BAC
BCWS 50%
BCWS 10%
$
Time
Completion Date

Profit in the B/EAC Box

- **BAC…Sets profit pool on Cost Plus contract!**
- **Box projects $150M in profit across 90% - 50% - 10%**

  90% BCWS - $1.5B * 10% (low risk) = $150M
  10% BCWS - $1.0B * 15% (high risk) = $150 M

- **Total Program Budget differs by $.5B**

  90% - $1.5 + .15 = $1.65B
  10% - $1.0 + .15 = $1.15B

- **Integration of risk with Program Estimate and EV**
  - **Critical to program budgeting for Realism**
  - **Management questions … assumed consequences**

EV with Risk beyond IBR

- Drive EV beyond deterministic (single value) process
- Need to add Technical and Risk Performance Index
  - TPI and RPI provide more transparency
  - Better understanding of variance
    - Management attention that is effective …
    - Mitigate Risks and understand Uncertainty
- Are we over “estimating” with limited details
  - Select were to increase risk and tech tracking
    - Add Tech and Risk Perf Index to CPI and SPI
  - Indexing allows comparisons to a program baseline
- Understand variance given assumptions
  - How much “opportunity” has been taken

Risk/Opportunity Analysis

Positive -- Consequence -- Negative

Very High Value	High Value	Moderate Value	Some Value	Limited Value

Probability

	Minor	Marginal	Moderate	Serious	Critical
Near Certainty					
Highly Likely					
Likely					
Unlikely					
Remote					

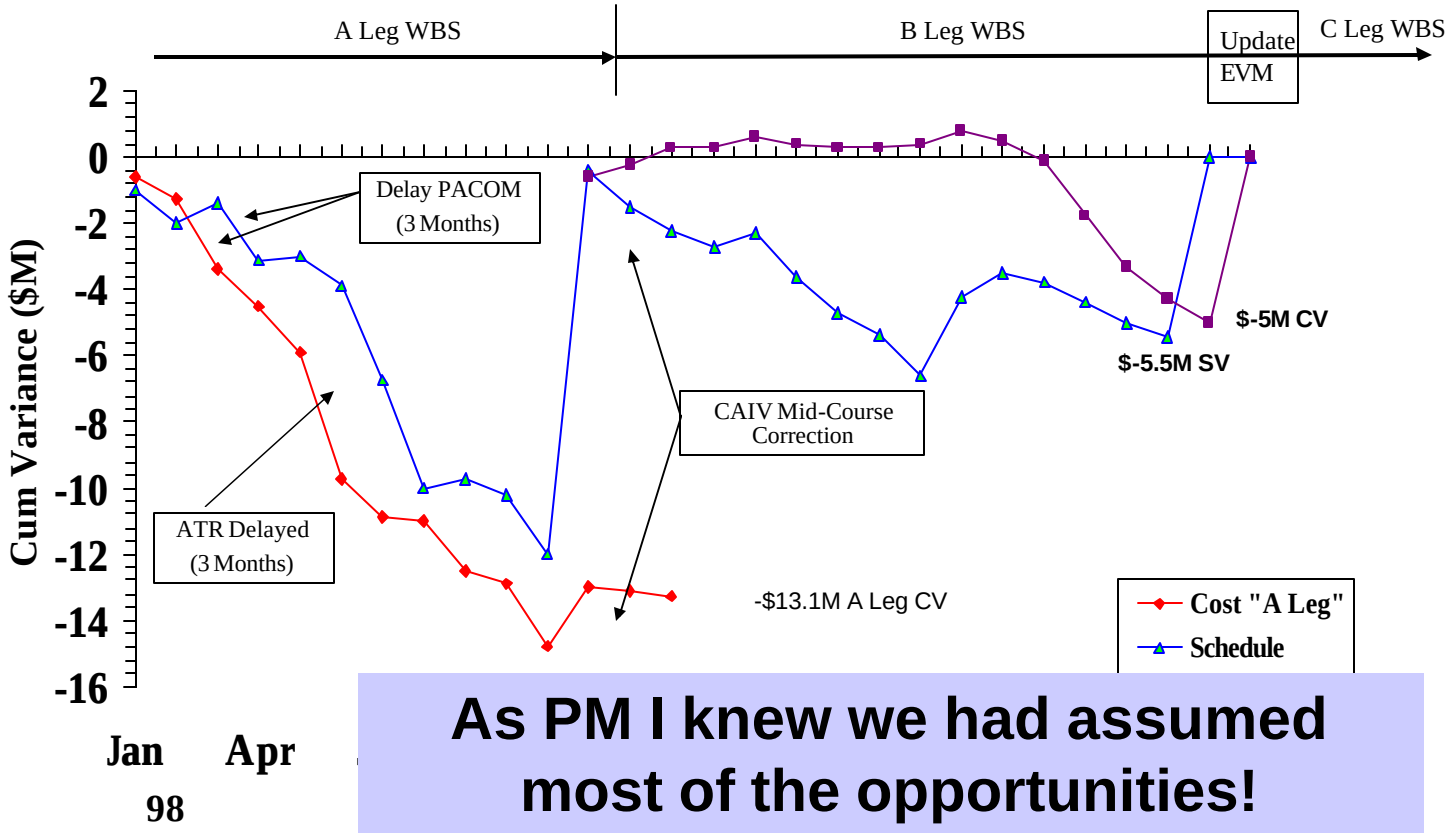
What Opportunities do you have given baseline!

Outline

- The Problem … risk and uncertainty in the program
  - Old 5000 & PPBE wanted point solutions
  - New DoD 5000 wants realism…
  - Management Team needs to join forces
- A Management issue … not a technical issue
  - Many ways to incorporate risk into cost estimates
  - Risk CoP briefs … desire to quantify risks
- Earned Value/Contracts incorporate realism
  - NDIA RISK/EV working group … survey
  - Proposed approach … evolving concept
- Discussion … managers require integration!

GBS EVMS Evolution

Cumulative Dollar Variance



As PM I knew we had assumed most of the opportunities!

Driessnack

As of Jun 00
Rebaseline

Management 1974

Peter F Drucker

- **"Above all, disagreement is needed to stimulate the imagination. One may not need imagination to find the *one right* solution to a problem. But then this is of value only in mathematics. In all matter of true uncertainty such as the executive deals with – whether his sphere be political, economic, social, or military – one needs creative solutions which create a new situation. And this means that one needs imagination – a new and different way to perceiving and understanding." pg 473**

Does your MANAGEMENT involve imagination ?

- **"…the effective decision-maker compares effort and risk of action to risk of inaction. There is no formula for the right decision here. But the guidelines are so clear…act if on balance the benefits greatly outweigh cost and risk; …" pg 476**

Are you an "effective decision-maker ?

- **A man who knows only the skills and techniques, without understanding the fundamentals of management, is not a manger ; he is, at best a technician.**

Are you "at best a technician" or a MANAGER ?

Summary

- The Problem … risk and uncertainty in the program
  - Old 5000 & PPBE wanted point solutions
  - New DoD 5000 wants realism…
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- A Management issue … not a technical issue
  - Many ways to incorporate risk into cost estimates
  - Risk CoP briefs … desire to quantify risks

- Earned Value/Contracts incorporate realism
  - NDIA RISK/EV working group … survey
  - Proposed approach … break out of the box

- Managers must integrate process teams
  - Risk, Cost, Schedule, Technical …around WBS

Integrating Risk in Cost Estimates and Earned Value Management
A Management Issue!

Business Managers Conference May 04

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EV Survey at http://mdc.dau.mil/mdcsurvey/rm-evm03/rm-evm03.htm

Slides posted at

http://acc.dau.mil/simplify/ev.php?ID=37464_201&ID2=DO_TOPIC

Or go to http://acc.dau.mil and search "Driessnack"

You can see Hulett and Coleman full briefs by searching at the site on their names

ARQ Special Edition on Risk is available at

http://www.dau.mil/pubs/arq/2003arq/arq2003.asp#spring